

ASPIDES bi-weekly meetings

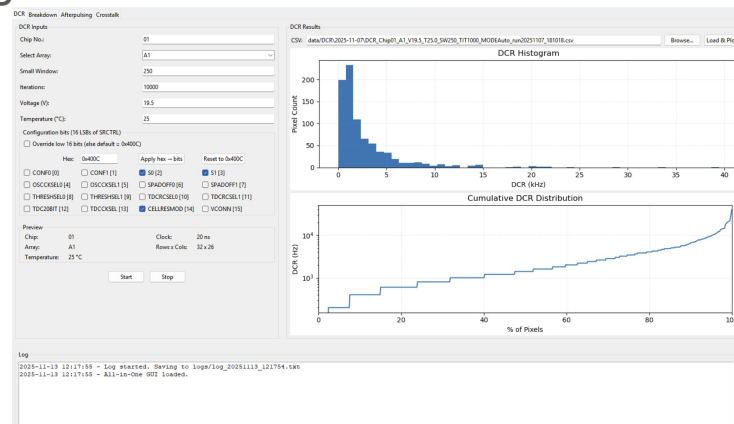
WP2-3 joint activities report

13/11/2025

Ongoing activities

Novel testing software developed for ASAP chips

- Unified firmware enabling standardized characterization of DCR, BD, AP, Xtalk
- User-friendly GUI for interactive testing



Characterization activities

- Ongoing measurements across multiple sections (BO, MI, NA, and PV)
 - Collect statistics and characterize chips before/after rad and cryo test

Ongoing activities

Radiation hardness tests:

- TID test performed in TO (see Fatemeh [slides](#))
- DDD test with neutrons performed @ LNL (see after)
- DDD test with protons @ TIFPA planned by middle December

Cryogenic characterizations:

- Setup preparation almost finalized

Displacement damage test @ LNL

Displacement damage test @ LNL

Displacement damage test neutron (from d on Be reaction) @ LNL

Irradiation performed on the 27-28/10/2025 (beam test organized from the BO group)

Fluence reached: 3.95 E9 n_{eq}/cm²

Schedule:

- Online DCR measurement during irradiation on A1-A3
- DCR and BD measurements after irradiation steps (5 steps) on A1,A2,A3 and ASIPM
- AP measurement after step 3 (27th night)

Data path:

<https://drive.google.com/drive/folders/1-p6ODrHnRuqjd49jt-xa6jsXsojUFHX4?usp=sharing>

Setup @ LNL

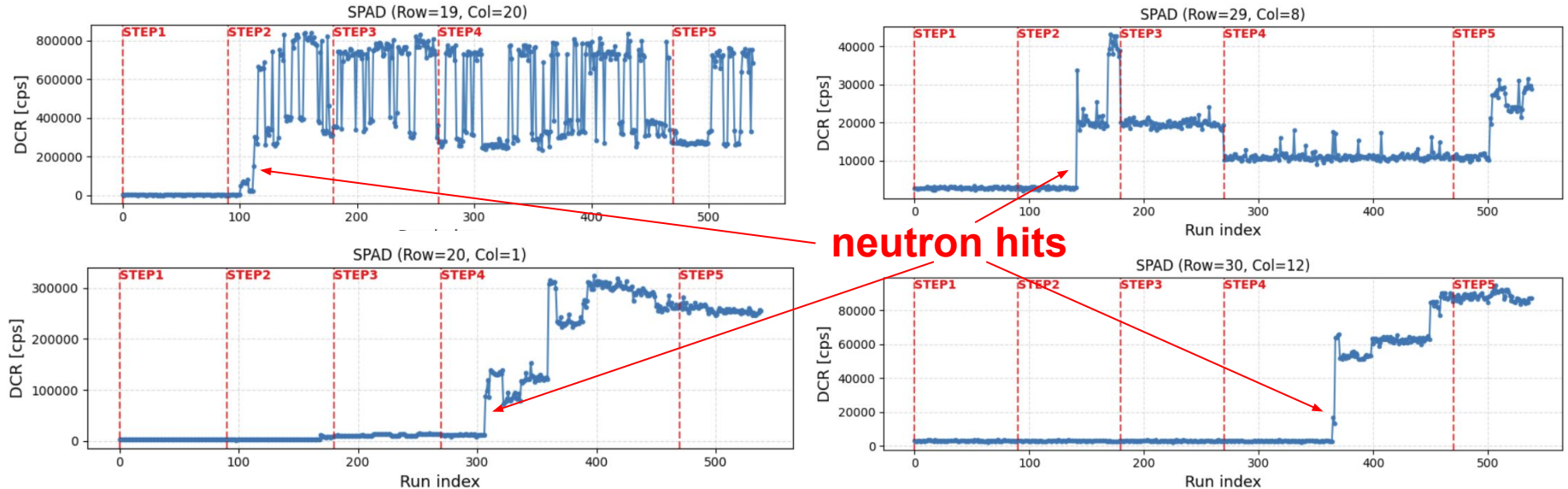


Beam current monitored by a picoamperometer, in control room.
[Data](#) with converter python script.

Online DCR measurement - A1 matrix

SPAD by SPAD DCR measured during irradiation with a sampling rate of ~ 40 s

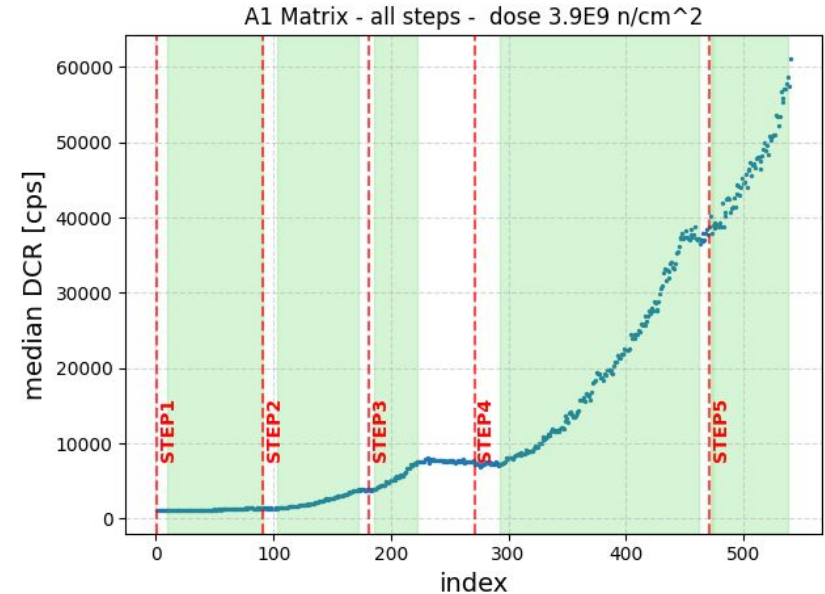
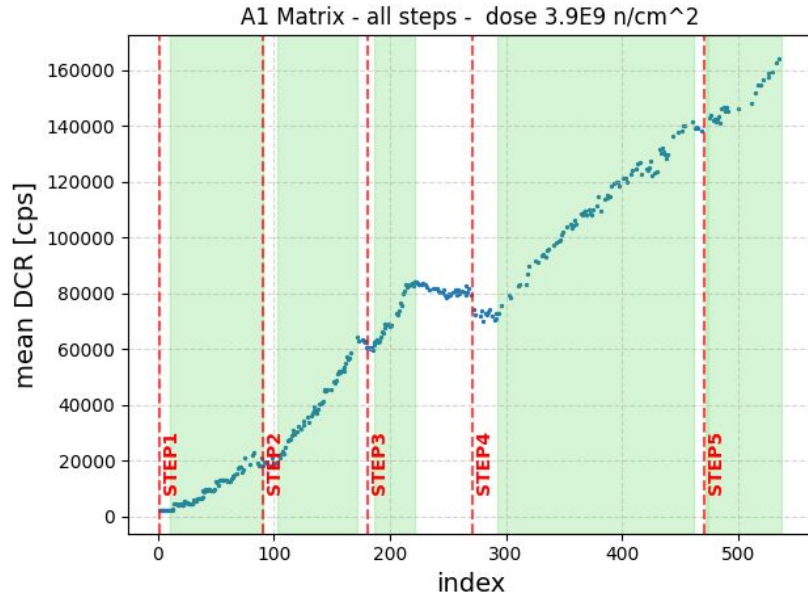
Example of DCR vs time (acquisition index) in a few SPADs



Online DCR measurement - A1 matrix

SPAD by SPAD DCR measured during irradiation with a sampling rate of ~ 40 s

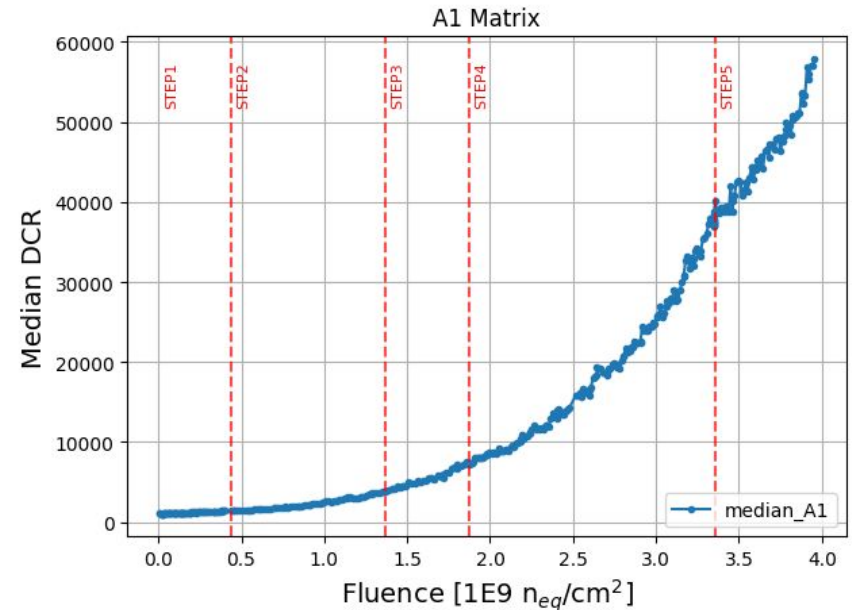
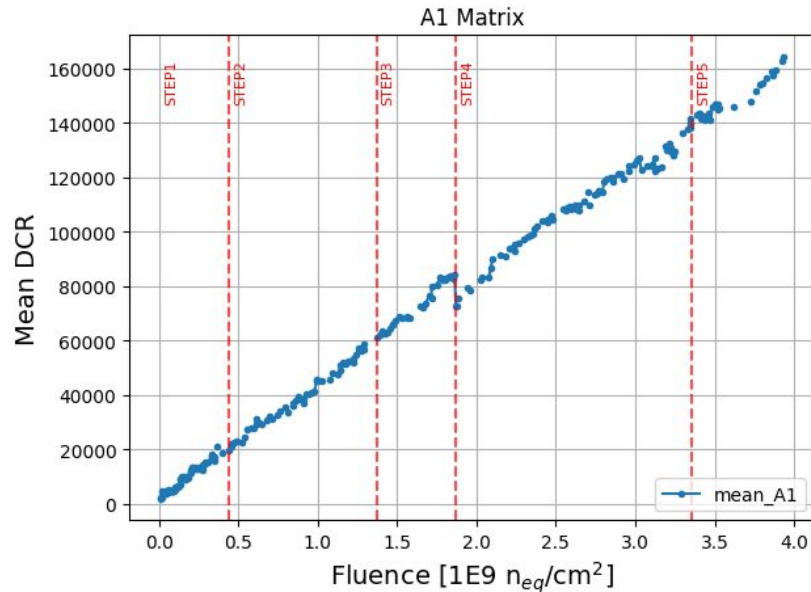
mean (median) DCR vs time (acquisition index)



Online DCR measurement - A1 matrix

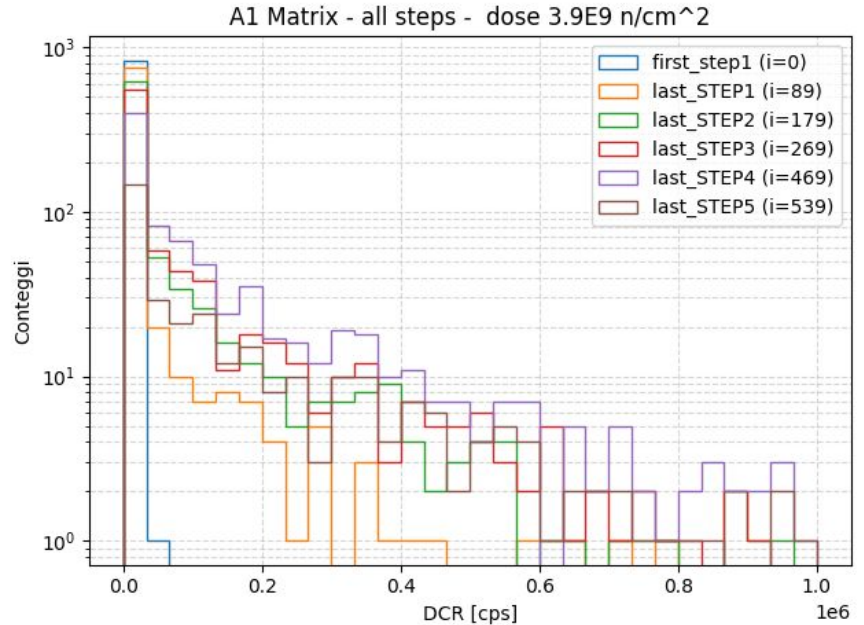
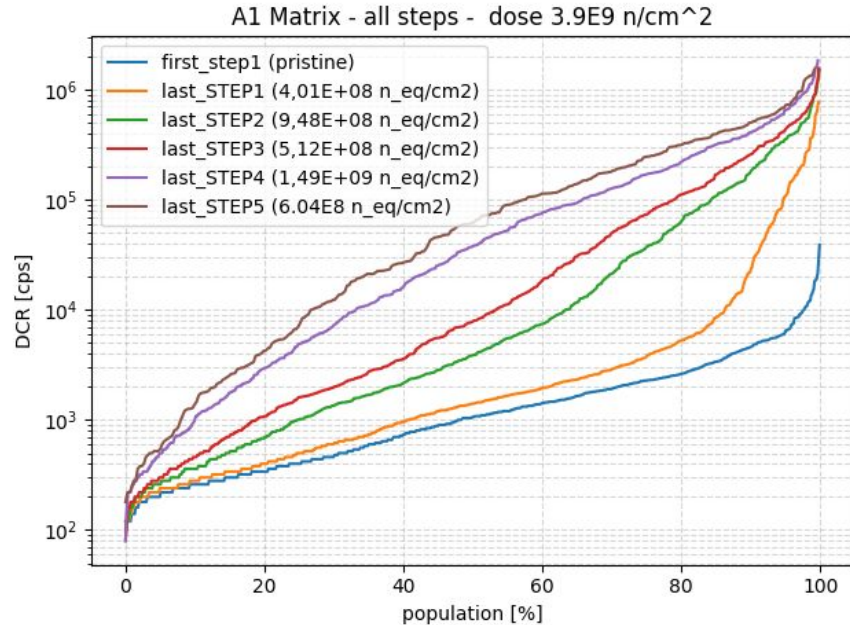
SPAD by SPAD DCR measured during irradiation with a sampling rate of ~ 40 s

mean (median) DCR vs dose



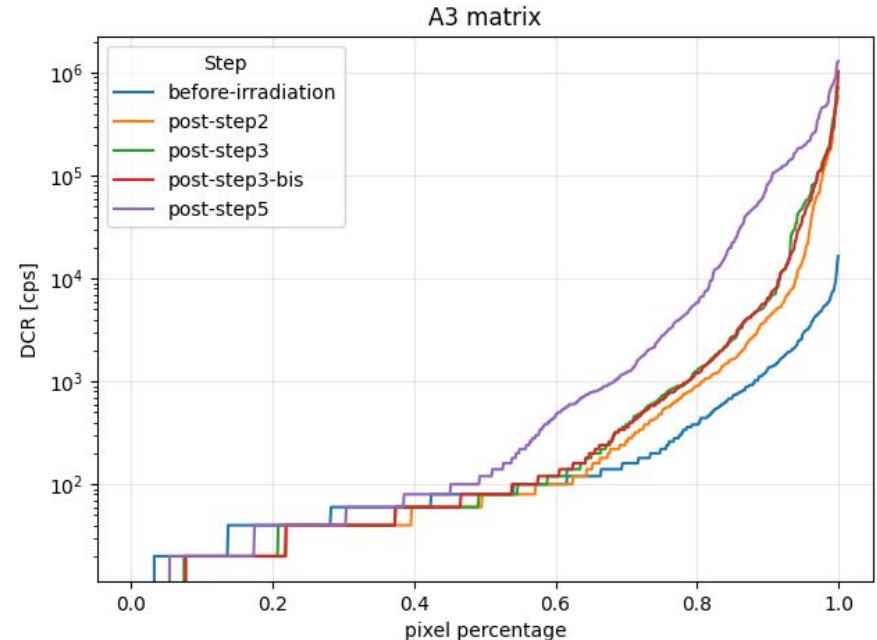
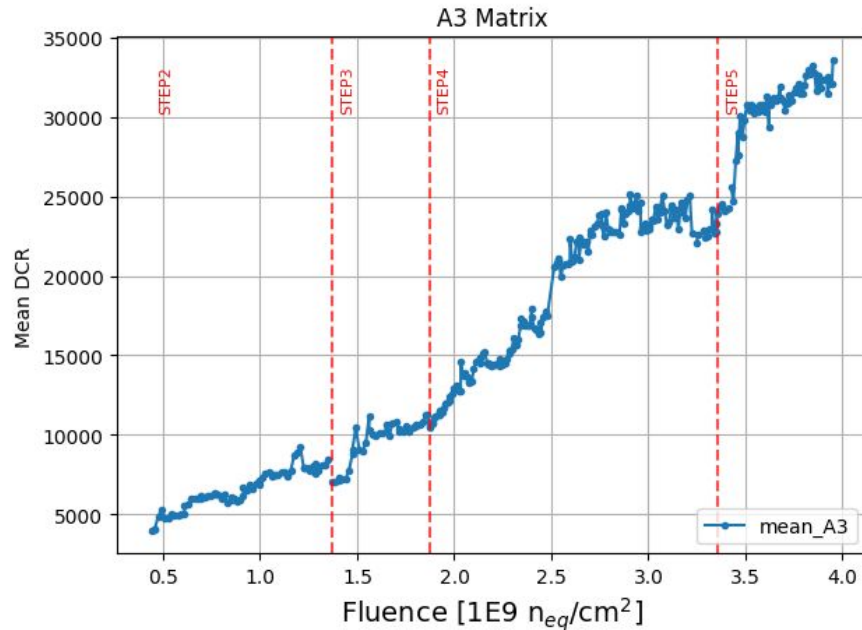
Online DCR measurement - A1 matrix

DCR distributions



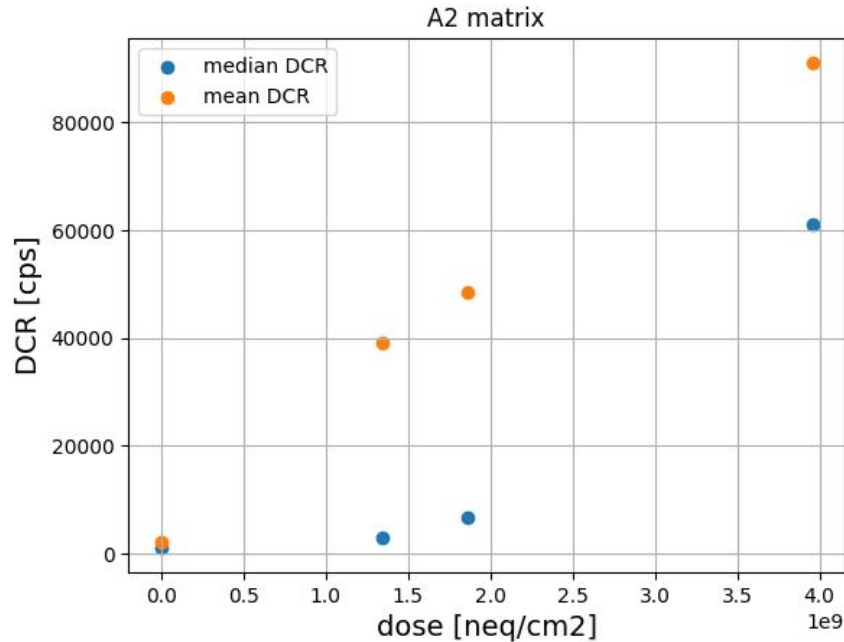
Online DCR measurement - A3 matrix

SPAD by SPAD DCR measured during irradiation with a sampling rate of ~ 40 s
mean (median) DCR vs dose

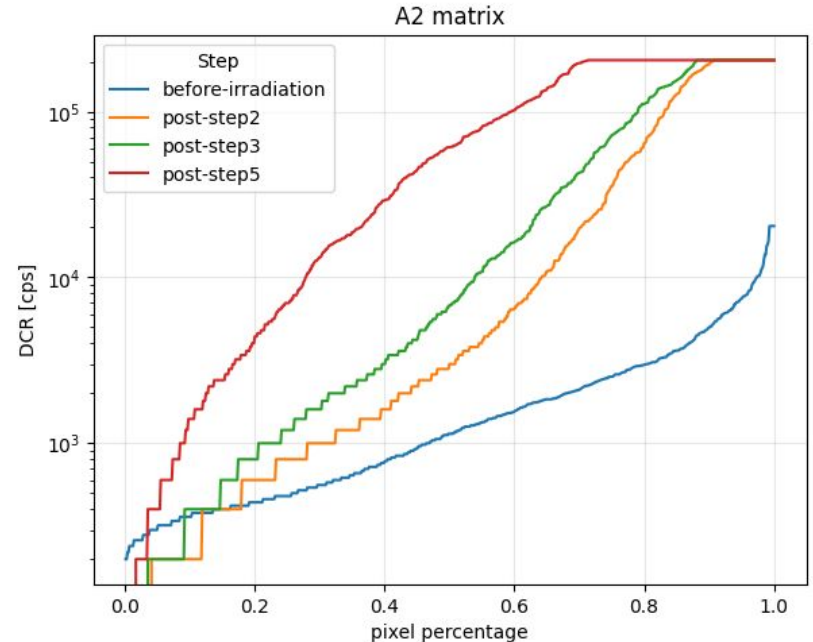


A2 matrix (offline measurements)

mean (median) DCR vs dose

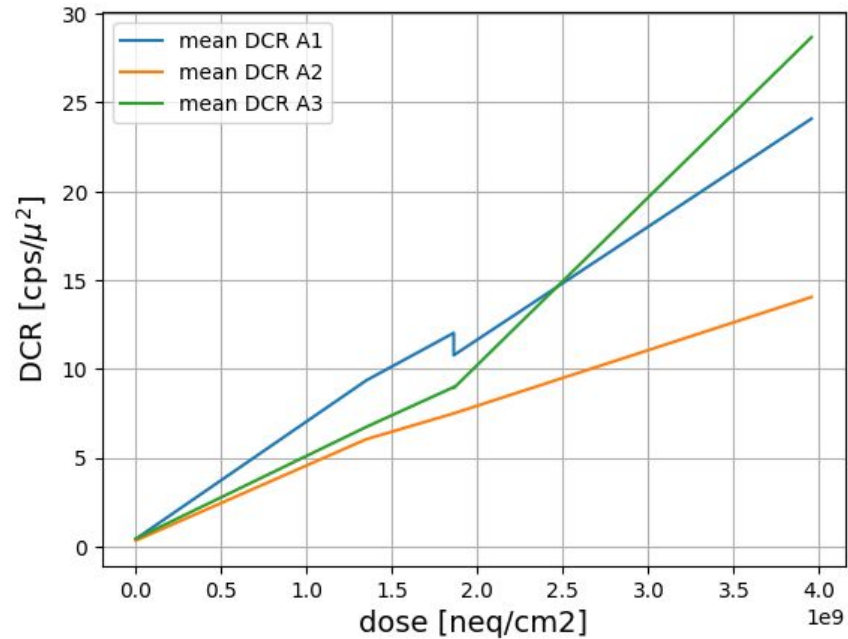


DCR distributions



A1-A2-A3 comparison

mean DCR vs dose



What's missing

- Repeat DCR, BD, AP, measurements to measure room temperature annealing effects
- High temperature annealing
-
-

Displacement damage test @ TIFPA

Tentative plan

Beam time availability: 2h on December 11th

Two devices to be tested

- 1 sample in low dose regime (up to a few 10^9)
 - Online DCR monitoring on a few SPAD sample (~ 50 SPADs)
 - Intermediate step DCR characterization (10^9 , 10^{10}) on a SPAD subset
 - time estimate: < 30 min irradiation + 30 min per intermediate characterizations
- Test of 1 sample in high dose regime (up to 10^{11})
 - Online DCR
 - Intermediate step DCR characterization (10^9 , 10^{10} , 10^{11}) on a subset
 - time estimate: 30 min irradiation + 30 min per intermediate characterizations

DB, AP, and Xtalk characterization only before and after irradiation

Person power: BO (2 persons) + NA (2 persons) + PV (1 person) + MI (1 person)

to be revised

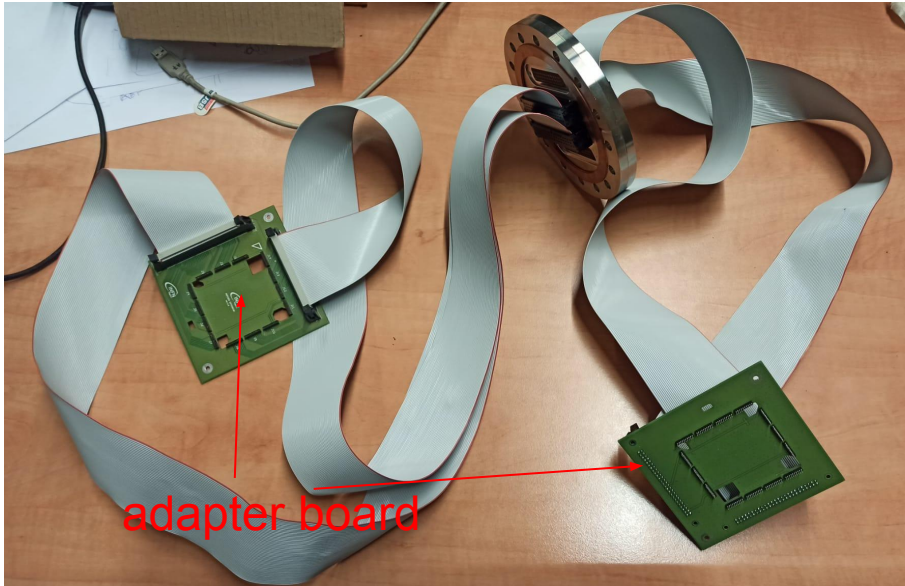
What's missing

- Fully characterize chips before the test(s):
 - BD, DCR, AP, Xtalk at room temperature (should be quick)
 - Activation energies -> DCR vs V_{ov} vs T
 - chance to measure it on a chip in Napoli, dep. of ingegneria (Luca et al.) maybe Bo
- Develop and test an additional firmware for DCR real time monitoring
 - sampling DCR of a subset of SPADs (likely some tens) with 10 Hz rate
- Minor setup preparation staff
 - temperature sensor and logging

Cryogenic characterization

Cryogenic setup

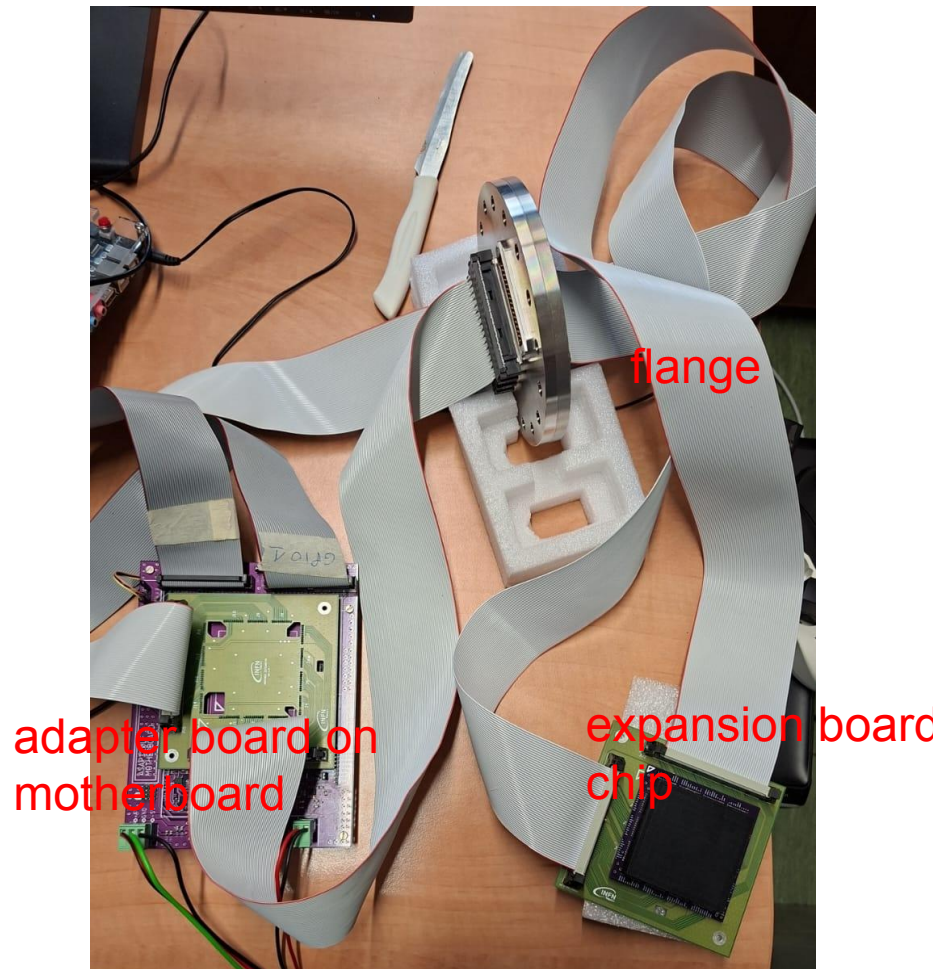
- Adapter boards and cable for test in cryostat realized



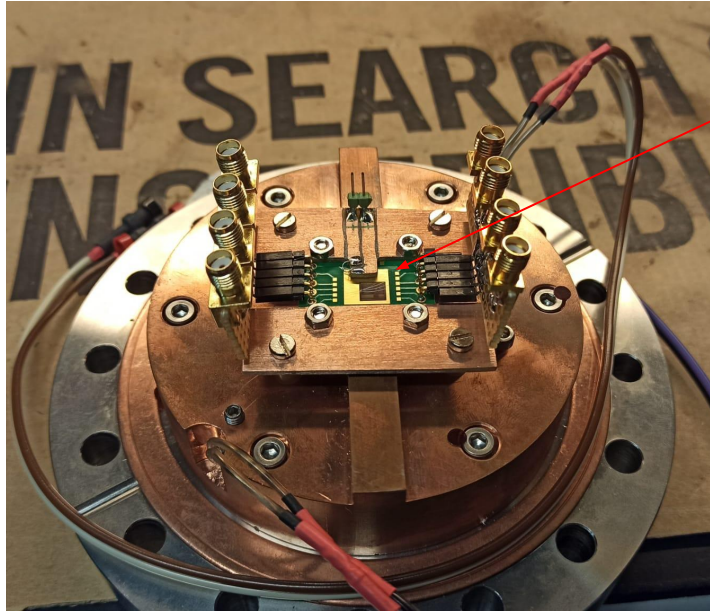
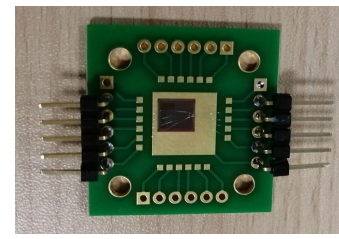
Cryogenic setup

Testing setup chain at room temperature ongoing

- DCR measurements are OK (same as with nominal setup)
- AP under test



Cryogenic setup for IV measurements

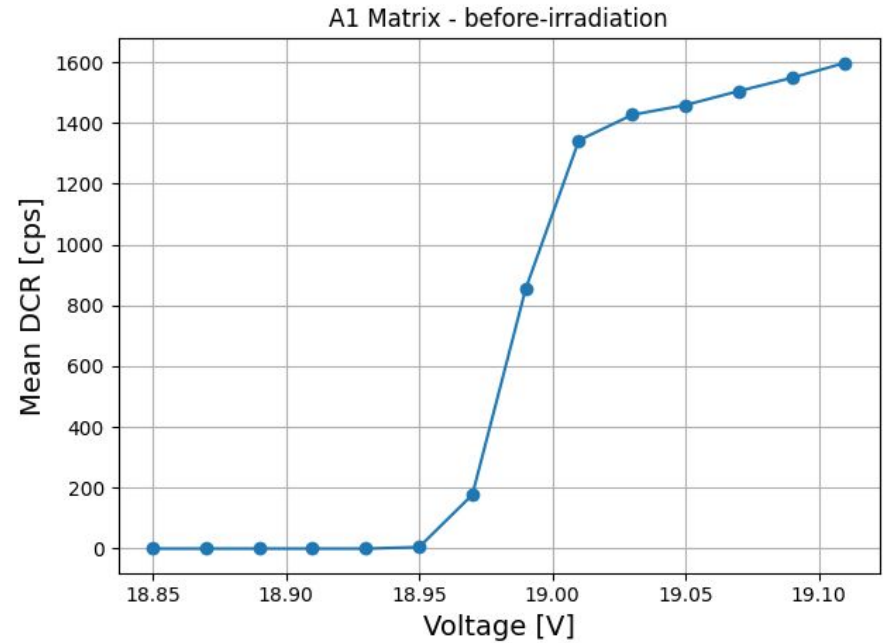
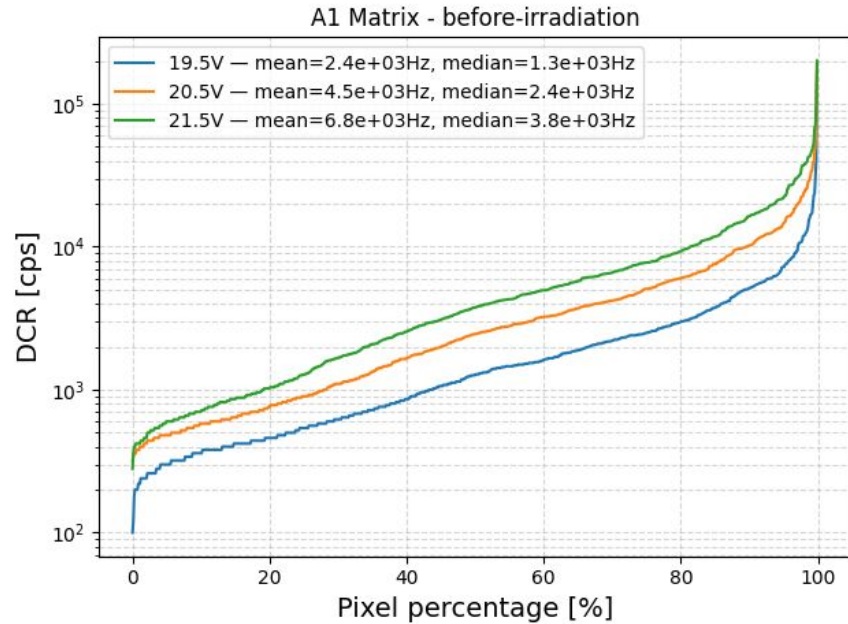


- 4 bare chips available for IV measurements
 - 4 test SPADs per chip
- Measure IV of in a dry system (in LN bath, with onboard heater) able to control temperature on chip down to LN.
- Adapter board for anode and cathode connection to the dry cryostat system flange.

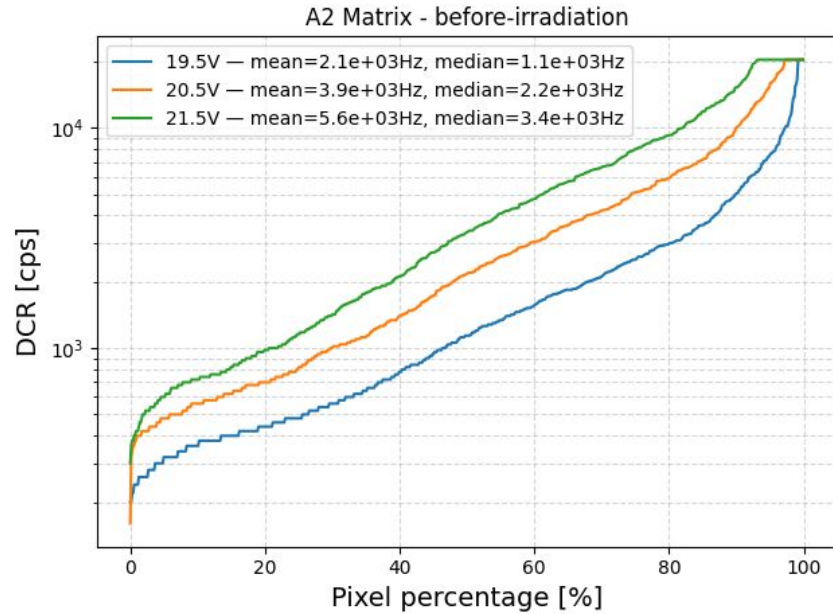
backup

before irradiation

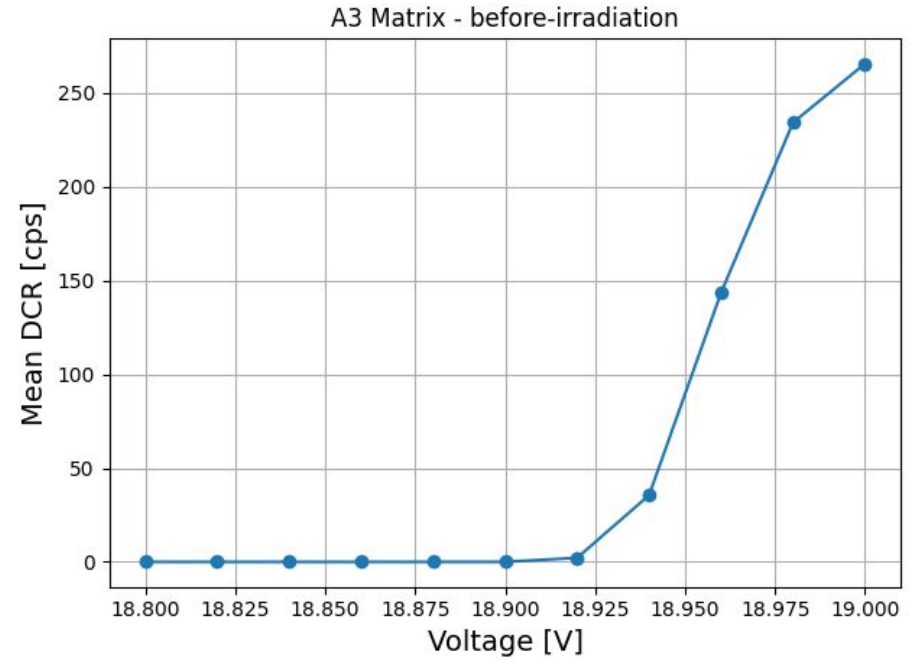
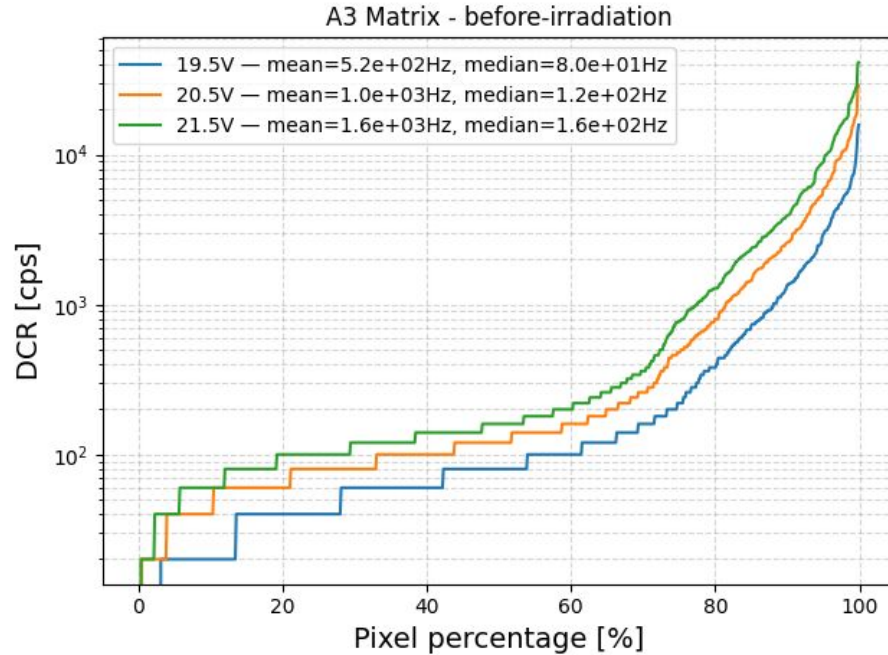
before irradiation - A1 matrix



before irradiation - A2 matrix



before irradiation - A3 matrix



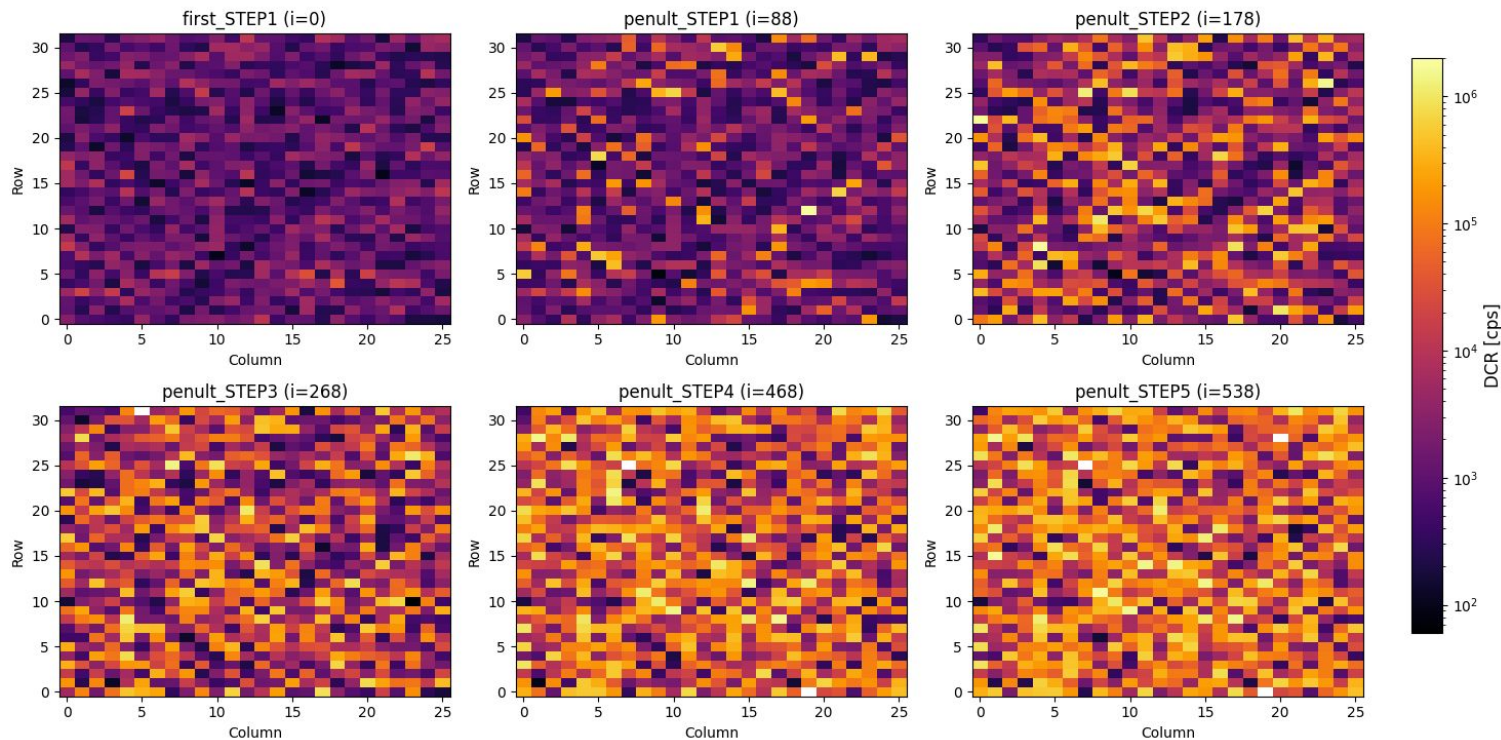
before irradiation - A3 matrix

- A1 mean DCR density: 0.3593 [cps/ μ^2]
- A2 mean DCR density: 0.3298 [cps/ μ^2]
- A3 mean DCR density: 0.4297 [cps/ μ^2]

after irradiation

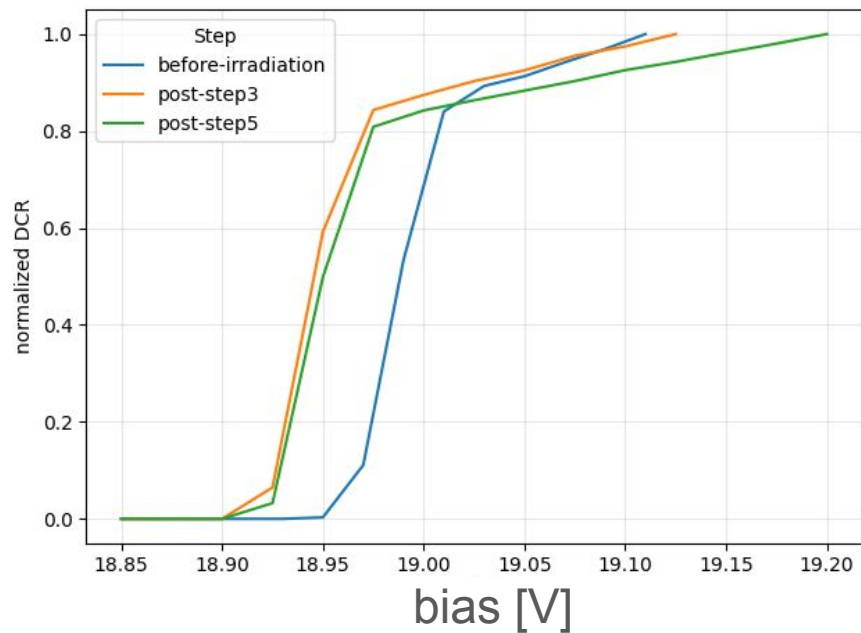
Online DCR measurement - A1 matrix

A1 Matrix - all steps - dose 3.9E9 n/cm²

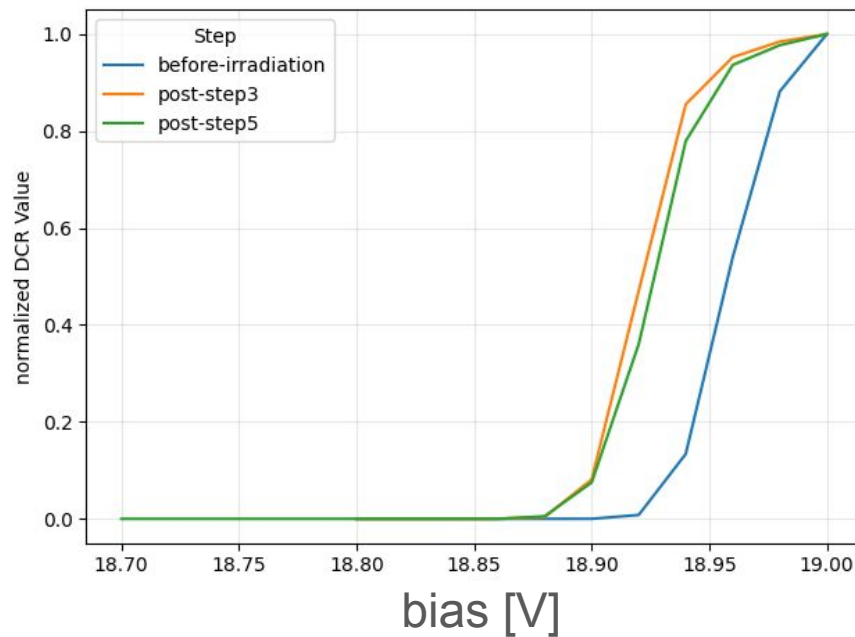


comparison BD voltage

A1 matrix

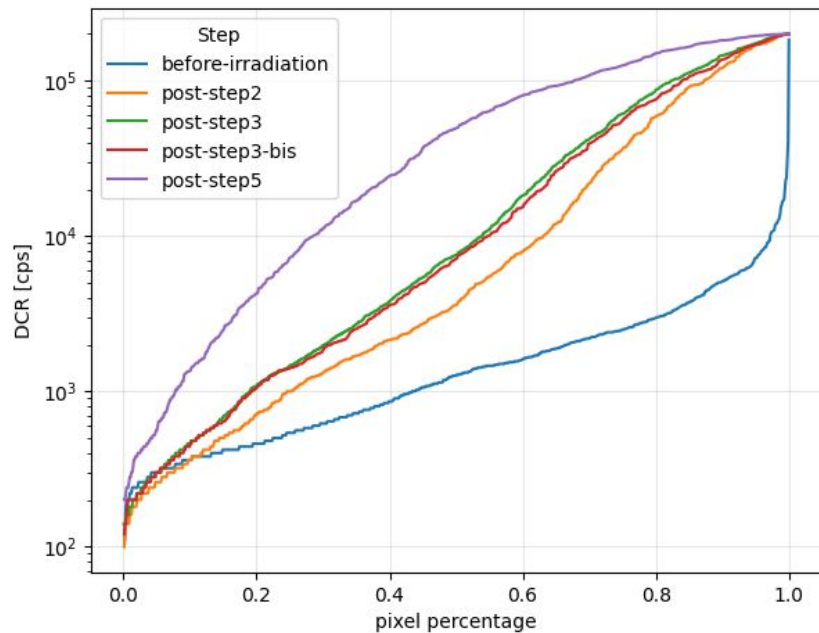


A3 matrix

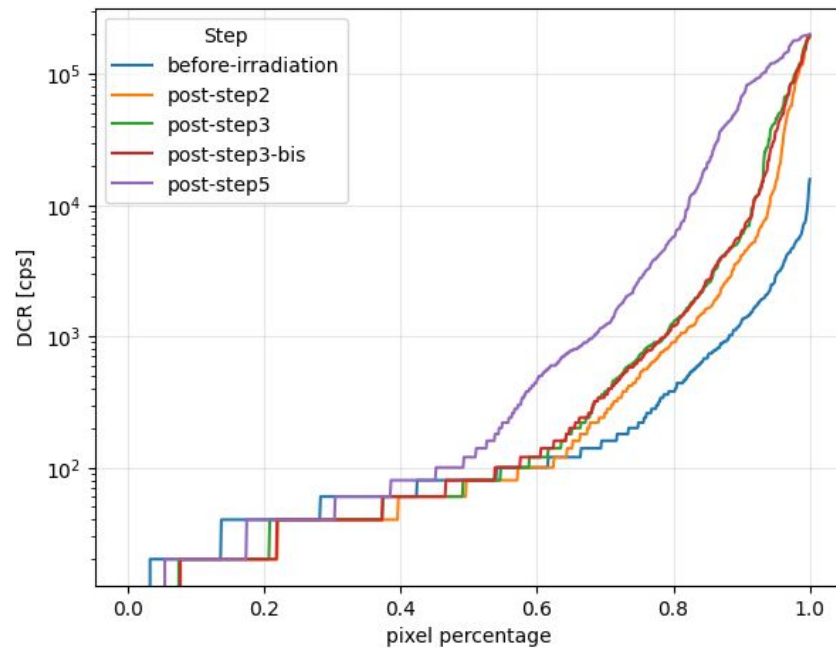


comparison DCR

A1 matrix

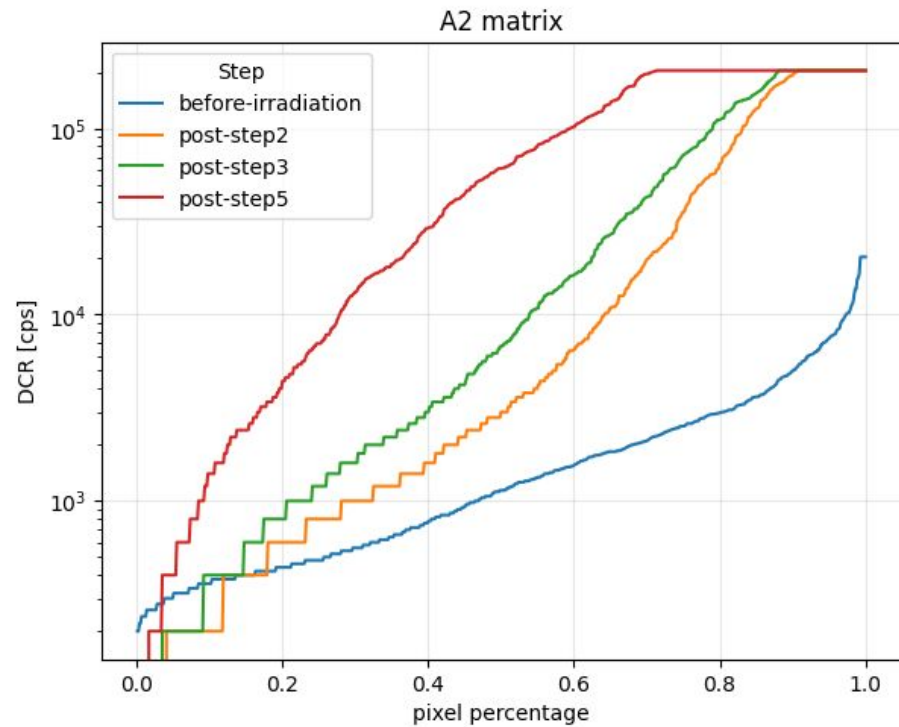


A3 matrix



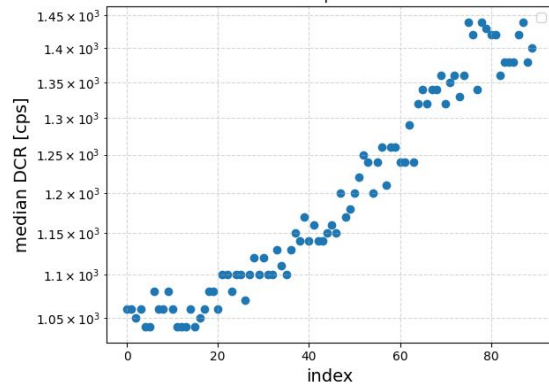
To be corrected for dead time

comparison DCR

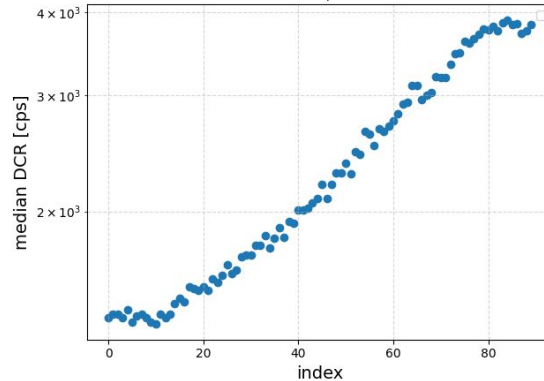


A1 matrix

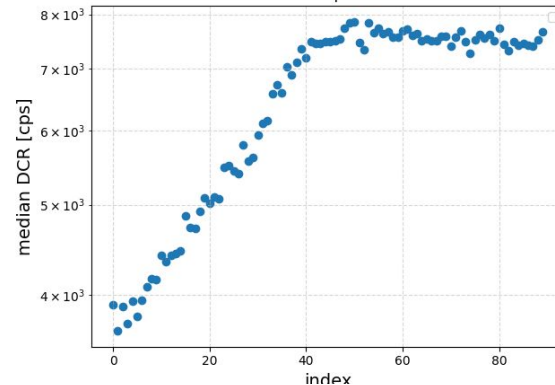
A1 Matrix - step 1 dose 4.01E8



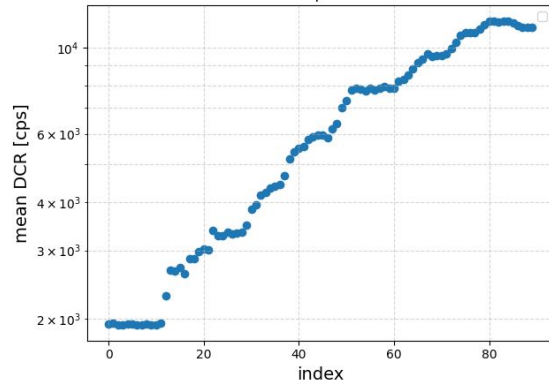
A1 Matrix - step 2 dose 9E8



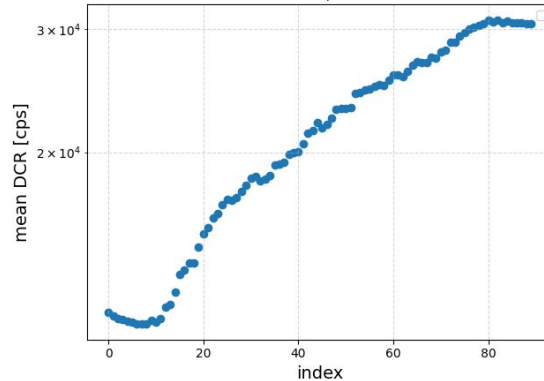
A1 Matrix - step 3 dose 5E8



A1 Matrix - step 1 dose 4.01E8



A1 Matrix - step 2 dose 9E8



A1 Matrix - step 3 dose 5E8

